

*mSolve, Building Science Services*

**Building Performance Inspection  
Including Moisture and Mold Assessment  
Harold Kelly Murphy Residence, Montgomery, AL**

**Report completed by: Francis Conlin, PE, CMR  
Site investigations: October 24, 2007 and December 4, 2007  
Report Date: December 28, 2007**

**Submitted to**

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**In Reference to  
Harold Kelly Murphy v. Southern Homes**

**Respectfully submitted by:  
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*December 28 2007*

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## Scope

This report summarizes two site inspections and subsequent analyses that were made to investigate performance aspects of the Harold Kelly Murphy residence in Montgomery, AL.

My first inspection was conducted on October 24, 2007 (MS 10-24-07). During this site visit, in addition to a non-invasive home inspection, I examined the wall cavity at four locations within the exterior wall that service technicians from Southern Energy opened from outside of the home.

My second inspection was conducted on December 4, 2007 (MS 12-4-07). During this inspection, I similarly inspected the exterior wall cavity at eight additional locations. These sites had been previously opened, inspected and sampled by the Healthy Homes of Louisiana (HH) on October 26, 2007. During this inspection I was assisted by Keith E. Leese, REHS, WLR, of LRC Indoor Testing & Research of Cary, NC. Mr. Leese gathered samples from the wall for microbiological assessment; and his conclusions are summarized in a separate report.

Also during the second inspection, bulk samples of the gypsum wallboard were removed from the interior of a closet. These samples were sealed in plastic and shipped to a certified laboratory in order to conduct structural tests for the gypsum board. The results were compared to the Standard Specification for Gypsum Board. Tests were conducted by Jason Holdeman of Progressive Engineering Inc. located in Goshen, IN. The results of this testing are described in a separate report.

My report also makes reference to and responds to specific claims made by the HH expert reports, specifically:

“Inspection of Southern Homes factory built home belonging to the Kelly Murphy family” By Bobby Parks of Healthy Homes of Louisiana, site inspection May 22, 2006; subsequently referenced as (HHR 5-22-2006).

“Follow up inspection of the Murphy family home” By Bobby Parks of Healthy Homes of Louisiana, site inspection October 26, 2007, subsequently referenced as (HHR 10-26-2007).

Findings
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The following findings are based on my direct observations and analyses and are rendered to a reasonable degree of engineering certainty:

### Claims of condensation in the wall cavity are unfounded

The plaintiffs claim that wetting due to condensation (and possibly other mechanisms) has caused the exterior wall cavities to have "extremely moist conditions," "structural deterioration" and "created fungal growth," (HHR 5-22-06) Page 2, Paragraph 1; and that the construction will cause the walls "to condensate much like a glass of ice tea in the summertime." (HHR 5-22-06) Page 3, Paragraph 2.

Historical dew point records demonstrates condensation in the wall cavities is highly unlikely. NOAA weather data<sup>1</sup> history for the Montgomery, AL area shows that in the past four years there have been only 12 days when daily outside dew point average is above the wall temperature resulting from the thermostat set point in the Murphy home. Figure 1 is a plot of the dew point history obtained primarily from NOAA data. This figure shows that mean dew points are lower than 75F for the overwhelming majority of the time. The mean dew point of 75 is exceeded only 12 times in the past 4 years, 6 of these times were in August 2005 surrounding a major hurricane event.

Thermodynamic laws provide that under conditions where the wall cavity surface is warmer than the dew point of the outside air, then wetting of the walls by condensation is impossible.

Exterior wall surfaces during summer are typically 3-4°F warmer than the inside thermostat set point temperature,<sup>2</sup> and since the homeowners keep their thermostat at 72°F; 75°F is a good reference point to indicate the improbability of condensation.

The HH expert has stated in exhibits and testimony that the dew point temperatures exceed 75°F for much of the summer; this is not supported by facts.

The HH expert has stated that during the periods from May to September that the outside dew points are routinely above 75°F.<sup>3</sup> In addition, the illustration used in the (HHR 5-22-06) Page 3, Figures 1 & 2 shows an outside dew point of 78°F; whereas in fact, the mean dew point in Montgomery, AL has NEVER reached 78°F in the past 4 years, and the maximum dew point reached 78°F once in 2007 and twice in 2006.

The claim that 75°F dew points are commonly reached is highly exaggerated.

<sup>1</sup> NOAA National Oceanographic and Atmospheric Administration is a scientific agency of the United States Department of Commerce focused on the conditions of the oceans and the atmosphere. NOAA manages the National Climatic Data Center, which is the world's largest active archive of weather data. NOAA data was not yet available for much of 2007; this, and April and September data was obtained from Weather Underground.

<sup>2</sup> Wall temperatures have been observed in similar homes to routinely be 3-4°F higher during the summer than the thermostat set point temperature; this is to be expected as summer-time heat enters the home through the walls.

<sup>3</sup> Apparently HH relied upon incorrect statements from an article and did not confirm this statement by looking at the data. Moisture Problems in Manufactured Housing: Probable Causes and Cures, Neil Moyer, et. al. Florida Solar Energy Center. Printed in ASHRAE IAQ 2001. This article states that "the outside air is constantly above a dew point of 75F during the summer months;" and is factually incorrect.

Movement of air-transported moisture into the wall cavity from the outside is limited by substantially airtight exterior sheathing and minimal duct leakage and other driving forces.

Air leakage is typically credited with 98% of water vapor movement through a wall and thus is the most important moisture transport mechanism when considering how water vapor moisture might enter a wall cavity.<sup>4</sup> If a significant amount of high dew point air enters a wall cavity – regardless of the wall construction or presence of interior vapor retarders - condensation within the wall cavity on the interior wall surface is a risk.

Condensation is only possible in the Murphy home wall cavity if the following condition is met: During the few days where the outside conditions reaches a dew point of 75°F, the outside air was able to come into direct contact with the cooler inside wall cavity. This condition would require that the walls were significantly leaky to the outside air allowing the free movement of air from outside into the wall cavity - such is not the case.

The exterior sheathing in the Murphy home is constructed in such a way to function as a substantially tight air barrier and significantly limits the amount of outside air that can enter the wall cavity (See Photo 9). Testing conducted as a part of this investigation shows the home to perform at the highest levels for air infiltration among residential homes.<sup>5</sup> This superior air tightness of the home is in part due to the substantial tightness of the exterior walls.

Furthermore, “driving forces” are needed to bring outside air into the wall cavity. The manufacturer has also significantly minimized such driving forces by constructing nearly air-tight ducts and a balanced ventilation system. Duct leakage was measured and found to be less than 2%, which is excellent by any duct performance standard.<sup>6</sup> The ventilation design brings fresh air into the home, which enhances positive pressures during heating and air conditioning (HVAC) operation. The pressure developed by the HVAC and by the fresh air ventilation systems operation was measured and found to exert no negative pressures on the home, and thus these create no driving force to bring outside air into wall cavities.

Unless significant outside air at dew points over 75°F are sucked into the wall cavity, condensation cannot occur.

The mean dew point temperature (not maximum dew point temperature) is the appropriate term to describe climate effects on wall cavities, regardless – even maximum dew point does not exceed 75°F to the degree claimed.

Mean dew point is the appropriate weather condition to evaluate the effect of climate inside a wall cavity and is used in guidebooks for that purpose.<sup>7</sup> Whereas instantaneous dew point will show effects on a glass of ice tea that, A) has no capacity for moisture storage, and B) is completely open to the outside air – this in no way reflects the conditions inside a wall cavity which are separated

<sup>4</sup> Air Barriers: Increasing Building Performance, Decreasing Energy Costs, The Architectural Record – McGraw Hill Companies – Construction Division <http://archrecord.construction.com/resources/conteduc/archives/0601duponttyvek-4.asp>

<sup>5</sup> The leakage rate of the building envelope as defined by a blower door test measured at 1470 CFM50; this number can be converted to an estimated annual estimated air change per hour of 0.28 which reflects a superior level.

<sup>6</sup> Duct leakage was found to be 27 cubic feet per minute (cfm) at a standard duct pressure of 25 Pascals, a common index is cfm duct leakage divided by floor area shows this home to be at “2%” leakage; few homes achieve performance levels this high.

<sup>7</sup> Builders Guide — Hot-humid Climates by Joseph Lstiburek — revised 2005 uses mean dew points in the appendices to describe geographic design criteria.

from the outside by an air barrier, and which is comprised completely of porous hygroscopic materials that absorb moisture from the air and store it without causing drops of liquid to form or damage to occur.

To be sure, there are more "peak" than "average" dew points above 75°F. For example 2007 had 19 days with a dew point over 75°F and 13 of these were in August. However, these high dew point periods do not last throughout the day and only two of these days had an average dew point of 75°F or higher.

Furthermore, high dew point days tend to be hot, but not as humid as popularly believed. The average high temperature for the August 2007 month during days where dew point was above 75°F is 99°F, but during the heat of the day the relative humidity was low (relative humidity changes with temperature and is the major factor that influences drying). While the average high temperature was 99°F, the coincident average relative humidity was 38%. These exterior daytime conditions will have a strong moisture removal effect on building materials.

Moisture movement by vapor diffusion does not constantly add moisture into the wall cavity. Whereas air leakage typically accounts for 98% of water movement into a wall cavity, only 2% of water vapor movement through walls is credited to vapor diffusion and is considered to be the smaller, less important of water vapor transport mechanisms.<sup>8</sup> Vapor diffusion through materials, such as wall sheathing, is governed by vapor pressure – vapor pressure varies daily depending on the temperature and relative humidity of the air. On occasions during a day when net vapor pressure is directed towards the wall cavity, it is almost always followed by an even longer period of time on the same day where vapor drive is directed out of the wall cavity.

An interior vapor retarder does nothing to slow diffusion from the wall cavity towards the outside, and although an interior vapor retarder indeed slows drying by diffusion towards the inside, such drying is not eliminated. Relative humidity during the day even in hot, humid climates can be significantly low, and under such conditions when the outside vapor pressure is lower than that in the wall cavity, vapor pressure directs moisture out of the wall cavity through the exterior sheathing and thus removing moisture from the wall cavity to the outside through diffusion.

The vapor retarder used in vinyl covered walls is typically a Class II vapor retarder and is not the much more restrictive Class I vapor retarder such as polyethylene sheeting.<sup>9</sup> A Class II vapor retarder will allow roughly ten times the vapor movement by diffusion compared to a Class I vapor retarder.

Describing that condensation occurs in the wall cavities like "a glass of ice tea" is a gross exaggeration under any circumstance.

On the rare days that condensation is even possible, in order for condensation to occur the walls must also be in direct contact with the outside air through a combination of a leak in the air barrier and a driving force that brings the outside air into the wall cavity. Even if all of these conditions are present, the wall cavity is made up of hygroscopic materials that absorb and adsorb moisture

<sup>8</sup> Air Barriers: Increasing Building Performance, Decreasing Energy Costs, The Architectural Record – McGraw Hill Companies – Construction Division <http://archrecord.construction.com/resources/content/archives/0601duponttyvek-4.asp>

<sup>9</sup> Building Science.com Building Science Digest 106, Understanding Vapor Barriers. By Joe Lstiburek

and provide a “hygric buffer” against condensation<sup>10</sup> – this is completely different than a cold glass of tea that cannot absorb and store moisture. A glass of ice tea is also close to 32°F and will express robust condensation when exposed to outdoor summer dew points of 75°F – the air continues to loose moisture as it drops almost 30°F. Whereas, if we use a more realistic temperature as is found in the home, such robust condensation will not occur. The temperature of air near a tea glass at 70°F will drop at most only a few degrees and will result in very little, if any, liquid condensation. Certainly a wall cavity will never appear “like a glass of ice tea.”

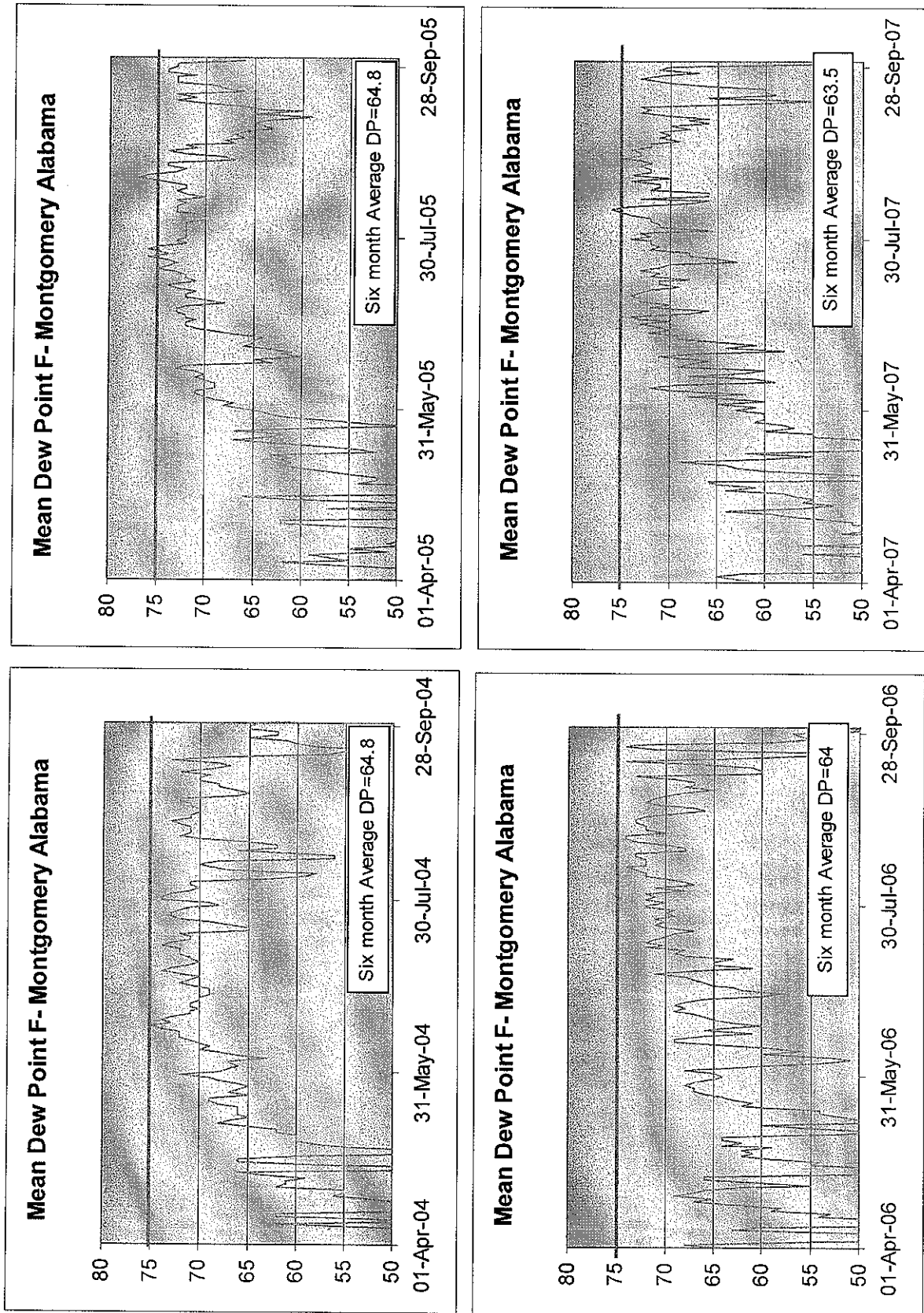
It is well documented that condensation can be controlled by reducing the entry of moisture. Moisture control handbook by Joe Lstiburek states “Concealed condensation can be controlled by reducing the entry of moisture into the wall cavities or by elevating the temperature of the first condensing surface.”<sup>11</sup> Reducing the entry of moisture is part of the strategy that has been successfully employed in the Murphy home.

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<sup>10</sup> Building Science for Building Enclosures by John Straube and Eric Burnett — 2005 Chapter 8.3 “Storage provides the buffer in time between the deposition and removal of moisture.” Researchers at ORNL call this the hygric buffer.

<sup>11</sup> *Moisture Control Handbook: Principles and Practices for Residential and Small Commercial Buildings*. By Joseph Lstiburek and John Carmody. 1994. John Wiley & Sons, Chapter 1- Mold, Mildew and Condensation, Pg 12 Concealed Condensation.

Figure 1. Mean Dew Point Montgomery, Alabama Summer 2004 -2007



Source: NOAA & Weather Underground Custom History

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Other possible causes of reported soft wall in master bathroom are ignored

Exterior walls in the master bathroom of the Murphy home that were reported as having been "soft" have a history of plumbing damage and apparent rainwater intrusion.

By far the most common cause of moisture damage to an exterior wall is due to bulk water entry through unsealed penetrations, faulty wall flashing and cladding, defective door and window frames, and roof and plumbing spills and leaks. The HH expert has ignored these more common and more likely causes of moisture intrusion. Evidence both of plumbing leaks and rainwater entry are in fact evident and completely overlooked by HH. A complete wall moisture investigation should first rule out these primary contributors before claiming that an isolated soft wall to be the result of condensation and vapor retarders.

The homeowner reported during deposition of a previous flooding/plumbing leak in the bathroom immediately adjacent to the area of the wall reported as having been soft.<sup>12</sup> Observation from inside the wall cavity show a clear "saturation line" that is common in flood damaged walls; this line is adjacent to the historic flooding area.

Furthermore, the unusual earth berm and railroad tie landscaping configuration at this home places the floor and wall cavities in the path of rainwater contact that apparently results in moisture intrusion. Rain water splash cascades down the back side of the railroad ties causing significant water to flow within millimeters of exposed bottom edge of the wall sheathing that is normally protected by skirting.

Also, at the site near the master bathroom wall reported as soft, there has been an on-site modification to the exterior plumbing that is improperly repaired leaving the bottom plastic open, and the floor cavity is exposed to the rain water splash described previously. Video taken from the crawlspace during simulated rain beneath the same bathroom wall demonstrates this as a probable site of rain water entry.

Moisture elevation measured from within the floor cavity and nearby wood joist and sheathing members support the finding that spills and or rain/bulk entry continue to occur, are accumulating in the floor cavity and are a probable contributor to any soft wall history.

Impact damage is evident both inside the master bathroom and inside the wall cavity.

Examination of the wall cavity also showed that the wallboard has been damaged by impact severe enough to break the paper from the gypsum; this impact has also apparently cracked the gypsum core. This impact damage is also demonstrated on the inside of the home; the "soft" area of the wall exhibits a rectangular indentation that could only have been made by some type of impact. The effect of the impact damage could allow the gypsum to "flex" with the appearance of being soft.

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<sup>12</sup> Harold Kelly Murphy deposition, Pages 37-39.

## Structural deterioration of walls is not demonstrated

### Structural deterioration of gypsum wallboard has not been demonstrated

Claims of structural deterioration by the HH expert is not substantiated by any measurement or testing. Samples of the exterior gypsum board which were cited by the HH expert as having "extremely moist conditions and structural deterioration" were taken from the Murphy home and sent to a certified materials test lab to conduct standardized structural testing. Tests were conducted for flexural strength, core hardness and nail pull resistance, in each test the exterior gypsum wallboard far exceeded the minimum performance outlined in the Standard Specification for Gypsum Board (ASTM C 1396 – 06a).<sup>13</sup> The complete results of this testing conducted by Progressive Engineering Inc. are described in a separate report.

## The moisture content of the gypsum walls is mis-represented

### Moisture content of gypsum of 25-40% as cited by the plaintiff is not possible.

Gypsum above 10% moisture content is a slurry. The adjoining Figure 2 shows the commonly accepted moisture content adsorption isotherm for a variety of construction materials including gypsum. The ASHRAE adsorption isotherm for gypsum is seen to have relatively stable moisture content of a few percent throughout a large range of equilibrium relative humidity.<sup>14</sup> A key HH claim is reported elevated moisture content readings: "Consistent readings within the Murphy's perimeter gypsum walls were in the 25%-40% range. (HHR 5-22-06) Page 3, Paragraph 3. Gypsum wallboard cannot have a 25-40% moisture content. The HH expert misrepresents moisture content measurements of the gypsum wallboard.

The Gypsum Association also clearly states that moisture meters do not provide accurate moisture content reading for the gypsum wallboard.<sup>15</sup> Moisture meters can only provide a non-scalar value that is useful only to rank order the degree of wetness; furthermore the relative numbers are non-scalar meaning that a reading of 20% on a moisture meter does not imply that a sample has twice the moisture of a sample reading of 10%. Clearly a moisture meter can only be used appropriately to cite that gypsum board has more moisture compared to a similar site, and cannot make reference to excess moisture content.

<sup>13</sup> Standard Specification for Gypsum Board ASTM C1396: This specification covers Gypsum wallboard, designed for use on walls, ceilings, or partitions and that affords a surface suitable to receive decoration; and pre-decorated gypsum board, designed for use as the finished surfacing for walls, ceilings, or partitions.

<sup>14</sup> ASHRAE Chapter 23 — 2005 — Thermal and Moisture Control in Insulated Assemblies: Fundamentals

<sup>15</sup> Letter dated July 27 from Robert Wessel Ph.D. of the Gypsum Association

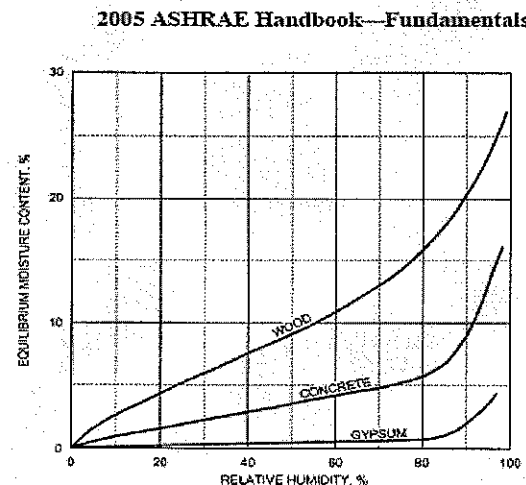


Figure 2. Adsorption isotherms for Wood, Concrete and Gypsum

Furthermore, even though gypsum board has the same interior wall covering, it has been observed that wall covering laminators may use a variety of gypsum suppliers, and that different types and manufacturers of gypsum boards have been observed in the same home with the same interior wall covering. Relative moisture levels as read from a moisture meter will vary for different gypsum board manufacturers depending upon the specific chemical makeup of the various gypsum boards.

All wall cavity moisture readings were normal and all wood framing members were solid, clean and in like-new pristine condition. None of the readings for the wood frame members was higher than 8.5% MC.

All relative moisture levels on the exterior walls were low (less than 8% relative) and were equal to the moisture level on the interior walls.

### Vapor retarders are a smaller factor in establishing the moisture balance inside a wall cavity

Diffusion, a moisture transport mechanism that is controlled by use of vapor retarders, represents a small part of water vapor movement through a wall.

Vapor retarders are used in wall systems to control water movement via vapor diffusion; the effectiveness and location of a wall vapor retarder is only one of many factors affecting wall moisture dynamics. Vapor diffusion is known to be a significantly less important moisture transport mechanism than moisture transported by air leakage.<sup>16</sup> Experts estimate that the amount of moisture vapor transported by air leakage can be 100 to 200 times higher than the amount transported by vapor diffusion, and can account for more than 98 percent of all water vapor movement through a building enclosure.<sup>17</sup>

HUD recognizes that vapor diffusion is a smaller factor than other condensation control measures and discusses this in the public comments of an additional prescriptive wall construction option proposed for the MHCSS.<sup>18</sup> HUD clearly states that "Manufacturers who chose to take advantage of the waiver are reminded that it does not consider the larger transport of moisture by air leakage, and that their designs . . . need to address those concerns."<sup>19</sup>

### Use of interior vapor retarders in the hot, humid climates is not unique to HUD code manufactured homes

Only recently (International Residential Code for 2006) has the requirement for an interior vapor retarder been lifted for site-built homes in all counties in Alabama. This is the same year that the

<sup>16</sup> Moisture Control Handbook: Principles and Practices for Residential and Small Commercial Buildings. By Joseph Lstiburek and John Carmody. 1994. John Wiley & Sons. Chapter 3 Design Considerations for Building Assemblies Pg 47 Wetting and Drying of building assemblies.

<sup>17</sup> Air Barriers: Increasing Building Performance, Decreasing Energy Costs, The Architectural Record – McGraw Hill Companies – Construction Division <http://archrecord.construction.com/resources/conteduc/archives/0601duponttyvek-4.asp>

<sup>18</sup> Department Of Housing And Urban Development 24 CFR Part 3280 Manufactured Home Construction and Safety Standards.

<sup>19</sup> Department Of Housing and Urban Development, 24 CFR Part 3280, [Docket No. FR-4578-F-02] Condensation Control for Exterior Walls of Manufactured Homes Sited in Humid and Fringe Climates; Waiver April 24, 2002 – This waiver proved unworkable and was revised and became effective in April 2006.

HUD code included an additional wall construction option: the "3280.504 (b)(4) wall"; this option allows a vapor retarder to be placed on the exterior of the wall cavity.<sup>20</sup>

When this home was built interior vapor retarders were also required by the Alabama residential and commercial building code. Even though an exemption to this requirement was made for homes which were deemed as hot, humid counties,<sup>21</sup> interior vapor retarders were used in site built homes in Alabama, and can be observed both in site-built residential and commercial construction throughout Montgomery.

### The levels of mold found in the Murphy home wall cavity reflect normal fungal ecology and are not elevated

Mold and mold spores can be found everywhere including wall cavities – the levels found in the non-flood damaged wall cavities of the Murphy home represent normal –not elevated- levels

My (MS 10-24-07) mold sampling results indicate no unusual amplification inside the home when compared to the current outdoor conditions; furthermore, the samples strongly suggest that the crawlspace is a dominant contributor to the molds that were found within the living area.

On my (MS 12-4-07) inspection, additional samples were gathered from the wall cavities and were evaluated separately by Keith E. Leese, REHS, WLR, LRC Indoor Testing & Research. The LRC findings that (except for documented historic flood areas) these walls represent normal fungal ecology are summarized in a separate report.

Visual inspection of the non-flood damaged wall cavities revealed wallboard, wood framing and batt insulation in like-new, pristine condition with no visible fungal staining.

### No HUD Code (CFR3280) manufacturing defects of any kind are evident

The wall construction is in compliance with the HUD Code 3280.504 and 3280.303 (b). HUD has offered a clear interpretation the HH claim that HUD Code section 3280.303 (b) should be applied to manufacturers' practices regarding placement of vapor retarder misrepresents HUD enforcement policy. To clarify this issue a letter was written from the Associate Deputy Assistant Secretary for Regulatory Affairs and Manufactured Housing that states: "Consistent with basic principals of administrative law, it is HUD's practice to hold manufacturers accountable for compliance with the standard that most specifically applies to a particular aspect of construction. Accordingly, there is

<sup>20</sup> Department Of Housing and Urban Development 24 CFR Part 3280 Manufactured Home Construction and Safety Standards, Section 3280.504: Condensation control and installation of vapor retarders. Option (4) "Homes manufactured to be sited in "humid climates" or "fringe climates" . . . are permitted to have a vapor retarder specified in paragraph (b)(1) of this section installed on the exterior side of the wall insulation or be constructed with an external covering and sheathing with a combined permance of not greater than 1.0 perms, provided the interior finish and interior wall panel materials have a combined permance of not less than 5.0 perms. Etc."

<sup>21</sup> Alabama voluntarily adopted the MEC/IECC building code for site-built homes. The 2000 IECC references vapor retarders in Section 501.1.1; and states that "Vapor retarders must be installed in all non-vented framed ceilings, walls and floors..." but goes on to stipulate an exception: "Vapor barriers are not required" in zones identified as hot and humid – vapor barriers may be used; the IECC stipulates only that vapor barriers are not required in hot, humid climates.

no case in which HUD has applied 3280.303(b) to a manufacturer that has complied with 3280.504(b)."<sup>22</sup>

The HH infrared camera images were not taken under accepted protocols and thus should not be used to make the HH report conclusions

The HH report indicates that the red and orange colors in infrared (IR) camera images are an indication of "air/heat infiltration". The image is not representative of a good infrared thermal report and was taken without following good practice guidelines for IR thermography that would be needed to infer such conclusions.

The use of the term "air/heat infiltration" in the photo caption is confusing. Heat is transported by conduction, convection and radiation. In these photos all surfaces shown have sufficient thermal mass such that the only reliable observations that could be made pertain to heat conduction. Thus, these images provide no defensible evidence of identified air infiltration in the perimeter walls.

Furthermore, the ASTM standards for tests using an infrared camera include many specific requirements not performed by HH. ASTM Standard Practice for Thermographic Inspection<sup>23</sup> protocol requires that thermal imaging be conducted on light frame construction only after there has been no solar influence for a period of three hours. ASTM Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems<sup>24</sup> calls for comparing IR images before and after operating a blower door. HH incorrectly applies both these ASTM testing protocols.

The walls in the Murphy home provide acceptable, durable performance

Acceptable performance includes the design and construction of building assemblies that may periodically gain moisture but remain durable and provide a long, useful service life.

There is no reliable indication that moisture levels elevate in these wall cavities such that structural integrity is affected or that a long and useful service life is reduced. The relationship of possible mold elevations in these wall cavities is discussed elsewhere in this report. With the exception of the water damaged area in the master bathroom, the mold testing conducted of the wall cavities

<sup>22</sup> Letter dated January 19, 2007 from William W. Matchneer III, Associate Deputy Assistant Secretary for Regulatory Affairs and Manufactured Housing to Brian D. Cooney Vice President, Government Affairs of the Manufactured Housing Institute. "... there is no case in which HUD has applied 3280.303(b) to a manufacturer that has complied with 3280.504(b)." etc.

<sup>23</sup> ASTM C- 1060-90 Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings (Standard revised in 2003) Appendix X2: Preferred conditions for performing infrared inspections of frame construction x2.3.1 Avoid Solar Radiation. This appendix speaks to proper use of IR imaging equipment.

<sup>24</sup> ASTM E 1186-03: Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems. The standard calls for using a blower door and an infrared camera together and comparing before and after infrared images.

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reflects nothing other than normal fungal ecology and regardless, such testing has never been used to establish structural integrity of walls.<sup>25</sup>

Other than the area with a history of flooding, inspections inside the wall cavity I made during (MS 10-24-07) revealed wallboard, wood framing and batt insulation in like-new, pristine condition with no visible fungal staining.

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<sup>25</sup> Institute of Inspection, Cleaning, and Restoration Certification (IICRC) S-520 *Standard and Reference Guide for Professional Mold Remediation December 2003* is destined to become the ANSI standard for inspecting possible mold contaminated building environments. The IICRC S520 describes a variety of indoor environments including wall cavities, and outlines methods to determine if they represent "Condition 1 or normal fungal ecology."

Home Description Observations
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Subject Home: Murphy Residence

Location: Montgomery, AL

Home Manufacturer: Southern Homes, Double Springs, AL

Model: DSDAL-38810-AB AK-651

Date of Manufacture: September 20, 2003

HUD Code Label: NTA1259057 – NTA1259058

HUD Thermal Zone: Provided with Zone 3 Insulation, home sited in Zone 1;

(Zone 3 has additional insulation that is acceptable in Thermal Zones 2 & 1)

HUD Wind Zone: 1

Number of Sections: 2

Construction Details: OSB and blackboard exterior sheathing, 2x4 walls, with vinyl siding cladding and a vented fiberglass shingle roof.

Site Visit Dates: October 24, 2007 and December 4, 2007

Significant on-site (not factory) modifications:

- Concrete slab porch added in front of home adjacent to living room with a pitched roof tied into the factory hip roof detail.
- Crawlspace is excavated into a hill – the sides of the home surrounded by a built-up earthen berm (except under the rear porch). A non-structural concrete block wall surrounds most of the crawlspace.
- Railroad ties laid along and directly against the lower exterior portion of all exposed exterior walls (except under the 2 porches).
- Wooden deck porch in the rear of the home with low pitch shed roof. Porch covers more than 75% of rear sidewall. The crawlspace is open under the deck (no skirting or foundation wall is present under the porch).

Exterior Wall Observations
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During my (MS 10-24-07) visit, I inspected 4 exterior wall cavity sites that Southern Energy service technicians open at my request. Three sites were opened from the exterior that were opposite from where HH had reportedly conducted wall cavity sampling from inside the home (HHR 5-22-06).<sup>26</sup> However, no evidence of a wall sample site was located in the area that HH identifies in his HHR 5-22-06 report as sample site location "End br w/c." A fourth cavity site inspection was added in the kitchen end-wall to provide an inspection site in each of the 4 exterior walls.

<sup>26</sup> Typically HH wall cavity sampling locations are obvious and indicated by a pair of holes in the wall that have been sealed with silicon-like white caulk. No evidence of a wall sample was located in the area that HH identifies in his HHR 5-22-06 report as sample site location "End br w/c" (Denotes as ✱ 2 Wall cavity in Figure 1); however a laboratory sample was apparently submitted by Healthy Homes and reported by HH's Lab.

During my December 4, 2007 (MS 12-4-07) visit I visually inspected eight additional exterior wall cavity sites. These sites had been previously opened, inspected and sampled by Healthy Homes (HHR 10-26-07). This second inspection was also attended by Keith E. Leese, REHS, WLR, of LRC Indoor Testing & Research. Mr. Leese summarizes his observations and findings in a separate report.

Figures 2-4 illustrate various locations of sampling sites.

My (MS 10-24-07) observations are as follows:

I found no evidence to support the allegation of wall cavity condensation or moisture accumulation leading to structural deterioration.

Three of the four inspections sites revealed wallboard, wood framing and batt insulation in like-new, pristine condition with no visible fungal staining. Photographs of these sites support these observations (Photos 2-4). It should be noted that some spots (freckles) are part of the normal appearance of these gypsum wallboards.

One inspection site from the master bathroom rear wall showed some apparent mold staining (Sample site MS 10-25-07 ■6 Visual Wall Cavity & Photos 5-7). The cause of this staining is apparently a previous plumbing flood in the bathroom. Saturation lines in the wall that are commonly associated with flooding are observed within the wall cavity; also, the homeowner reported a sink-plumbing failure directly adjacent to the stained wall cavity area. This wall stud bay adjacent to the sink was reported as soft; however, this wall had been previously impacted resulting in a "square shaped" impact indentation that broke the board and paper backing. An additional source of moisture in this area is rainwater and hose water entry from the landscaping and bottom plastic that is torn in this area.

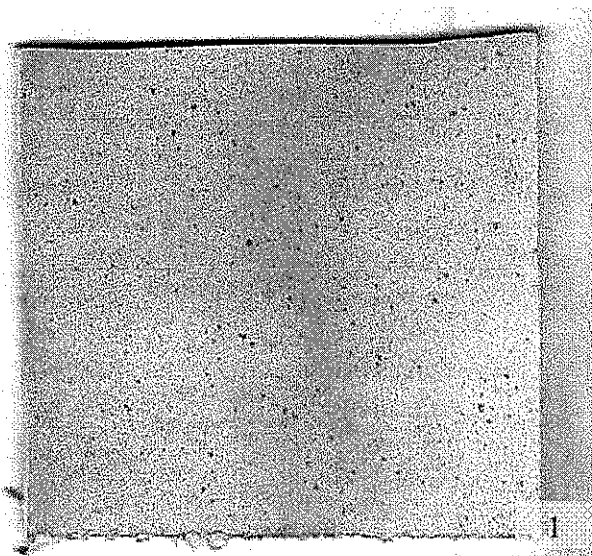


Photo 1: Interior view of new gypsum wallboard as delivered to factory. Spots (freckles) are a normal feature of the boards and should not be confused with mold.

One small area on the end-wall (less than 1 foot square) over the master bathroom tub exhibited "bumps" on the vinyl. Such bumps are sometimes found where moisture problems have occurred. It is most likely that this is the result of a singular event related to the previously described flooding problem in the bathroom. Floodwater could have easily traveled under the tub (where there is no carpet), and there is a nearly direct path from the sink that flooded to this wallboard. Further invasive inspection was not conducted of this small area.

Legend - Murphy Home: Various sample locations and Type Figures 2-4		
Report Reference	Approx location	Comment
HHR 5-22-06	✕1	Wall Check Spore Trap - Wall cavity & Air outdoors
MS 10-24-07	■1	Spore Trap - Air home to outdoors & Visual wall cavity
HHR 10-26-07	◆1	Bulk sample of wall cavity gypsum paper
MS 12-4-07	○1	Tape lift of gypsum paper & Air samples home and out

Figure 2. HHR 5-22-06 (✕) Sample Locations

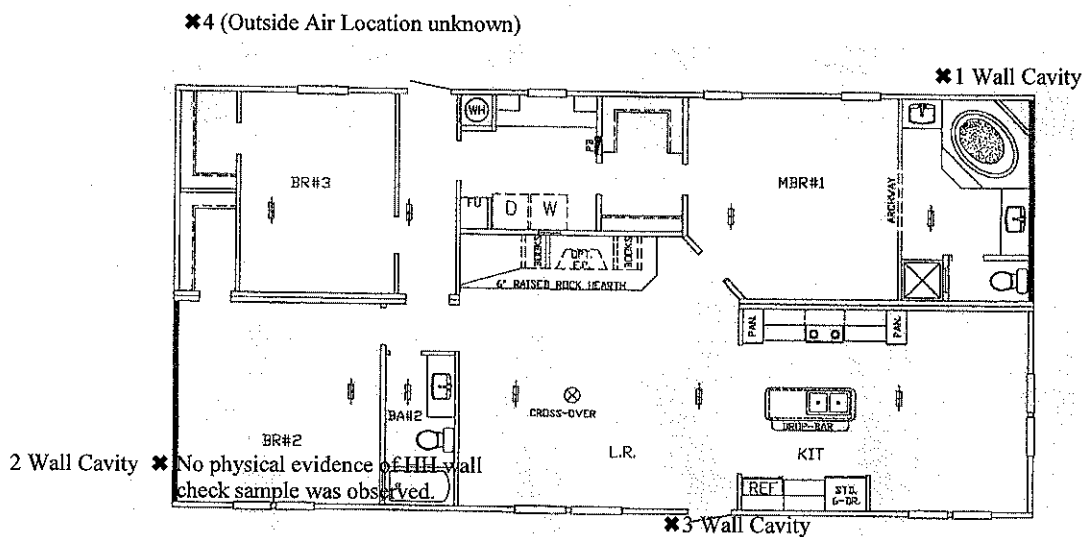


Figure 3. MS 10-24-07 (■) Sample Locations

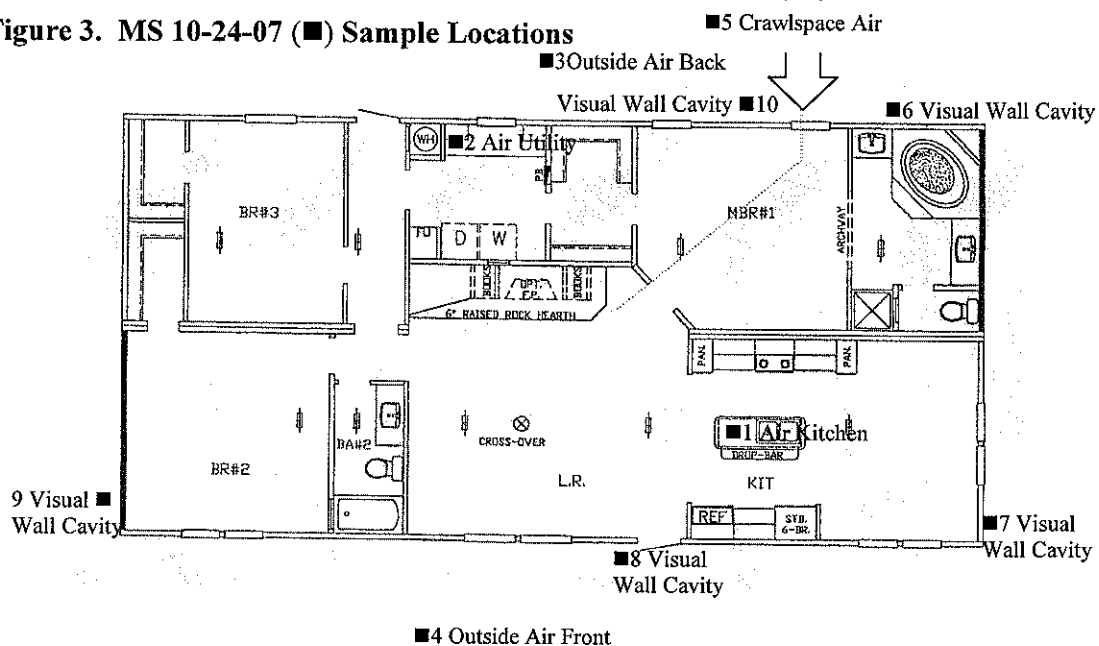


Figure 4. HH 10-26-07(♦) and MS 12-4-07 (●) Sample Locations

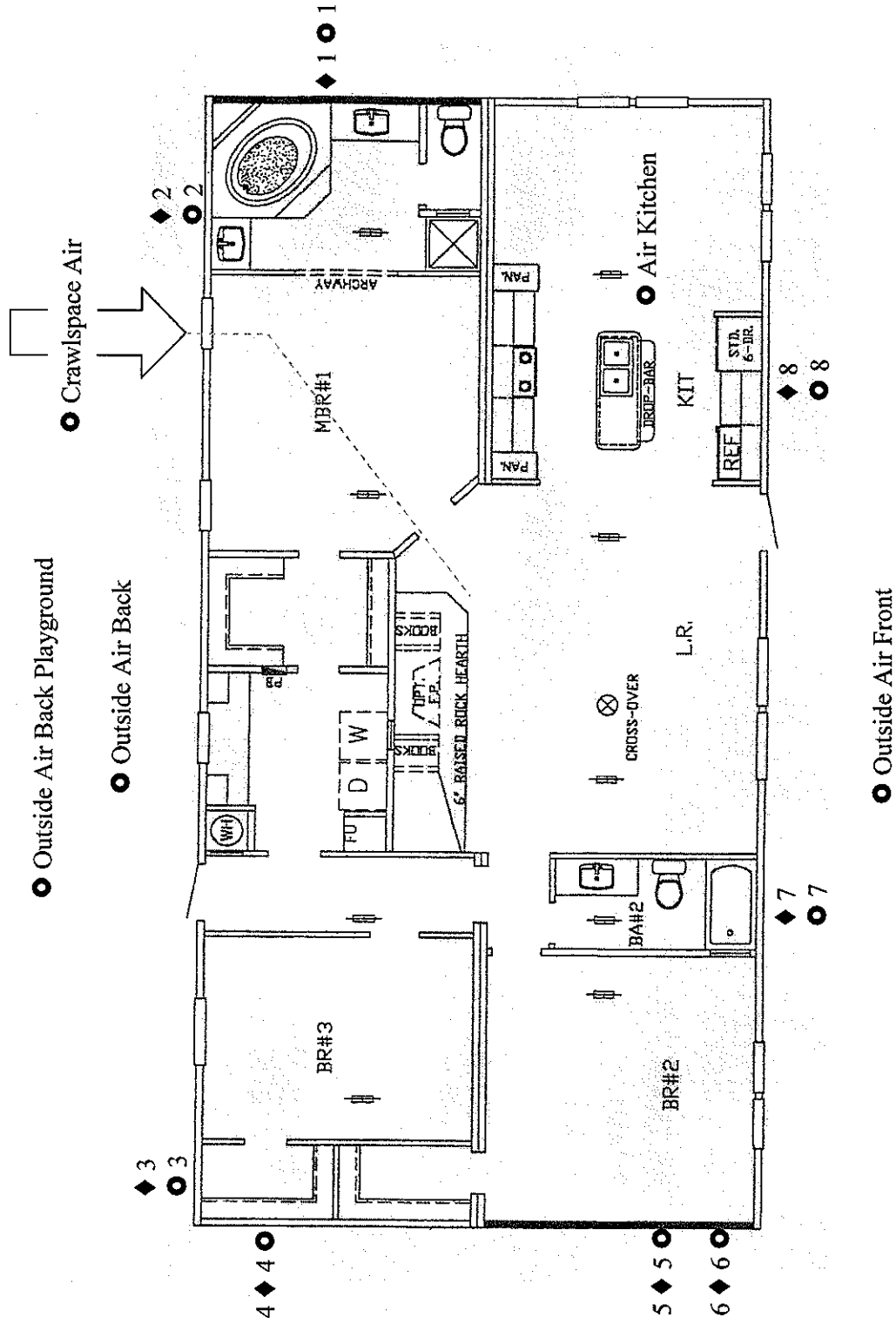
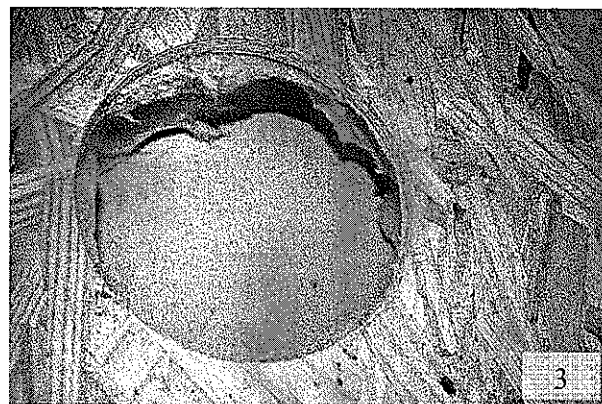


Photo 2: Living room wall cavity -MS (10-24-07) ■8- sample location at exterior wall near the porch light penetration. The exposed wallboard, wood framing and batt insulation are in like-new, pristine condition. Wall cavity observation was Condition 1 or "normal fungal ecology" and no adverse fungal evidence was present that suggests that the walls need or will need replacement. Evidence of the Healthy Homes wall check test is seen as the holes penetrating the interior wallboard. (HHR 5-22-06) ✕3.



Photo 3: Kitchen end wall -MS (10-24-07) ■7- sample location; wall cavity observation is Condition 1. The exposed wallboard, wood framing and batt insulation are in like-new, pristine condition. (Healthy Homes did not sample this wall.)



Bedroom #2 end wall -MS (10-24-07) ■9- sample location at exterior wall. The exposed wallboard, wood framing and batt insulation are in like-new, pristine condition. Sampling site by HH could not be located in this wall.

